Research on Optimization of Multi-Commodity Supply and Demand Logistics Network Based on Supernetwork

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ABSTRACT

For the realization, a qualitative and quantitative description of matching degree between the elements for logistics supply network and demand network, logistics super network models are constructed by the theory of super network. Faced with the problems of diverse demand and massive circulation for commodities, this article studies the structure of the logistics super network of multi-commodity circulation and establishes the continuous cost function of the logistics demand and supply, reflecting the logistics cost of different commodities in different phrases. This article aims to establish the optimization model of logistics supernetwork by aiming to maximize the matching of supply and demand of multi-commodity. The model is transformed into the variational inequality problem, and proves the existence and uniqueness of the equivalence solution. Use the case of the logistics supernetwork of coal, a modified projection algorithm is adopted and the fact is revealed that improving the supply capacity of the network matching may have the original 81.3% increase to 90.5%, improving the impact of the relationship between trades, matching degree can be increased to 90.1%.

KEYWORDS

Logistics Supply and Demand Matching, Modified Projection Algorithm, Multi-Commodity, Supernetwork, Variational Inequality

INTRODUCTION

With the continuous development of the logistics industry, logistics network has become the inevitable trend of development. More and more scholars have discussed the theory of logistics network, gives the different connotation and definition (Brimer, 1995; Alumur et al., 2012), through the continuous research of scholars, it can be concluded that the logistics network is characterized by multi-layer, multi-attribute, multi criteria, congestion and coordination, and the network with the above characteristics can be called supernetwork (Wang, 2011). The supernetwork refers to the network or large-scale network which is higher than that of the existing network, which reflects the relationship between the network and the overall characteristics of the network system (Nagurney, 2011; Nagurney, 2013). In order to analyze the relationship between factors and system characteristics of logistics network, introducing the ideas of supernetwork into logistics network modeling, has become a new research subject.

Supernetwork as a complex science, system theory knowledge includes optimization theory, network theory, game theory, variational inequality theory and projection system theory, etc. the research of the supernetwork focused on the supply chain network (Cruz, 2013; Manning, 2013;
Yu & Nagurney, 2013; Nagurney & Li, 2015; Jabbarzadeh et al., 2014; Ma et al., 2015). Knowledge network (Xi & Dang, 2007; Zhang et al., 2015), travel network (Ramadurai & Ukkusuri, 2010; Liao et al., 2010) and traffic network (Nagurney, 2006; Yamada et al., 2011; Yamada & Febri, 2015; Liao et al., 2017). Cruz (2013) and Manning (2013) draw out the social network from the three-level supply chain network, analysis of the commodity flow and social relations flow respectively, and then study the supply chain network and social network combination of supernetwork equilibrium, at the same time involves such problems as multiple products and multiple period problems. Yu (2013) and Nagurney (2015) discussed the problem of the supernetwork that two supply chain networks integrated, and proved that the combined supernetwork achieve the optimal equilibrium state of the system. Jabbarzadeh et al. (2014) and Ma et al. (2015) analyzed the optimization problem of the dynamic supply chain supernetwork system. Xi (2007) and Zhang (2015) study the knowledge sharing services and the formation of scientific and technological innovation team in the knowledge supernetwork environment. Yamada & Febri (2015), and Liao, et al. (2015) convert a supply chain network to transport network structure, prove that the supply chain network equilibrium model is equivalence with user equilibrium of traffic network.

At present, scholars have begun to use the supernetwork theory to study the logistics network. Julie (2011) built a logistics network and manufacturing network of supernetwork, which is used to solve the linkage problem of the two industries. Yang & Shi (2012) set up a multistage supply chain logistics competitive supernetwork equilibrium model which including logistics storage facilities and the supply and demand number of commodity. Pu et al. (2015) analyzed the relationship between the disaster network and the emergency dispatch network by using the supernetwork theory, and established the emergency logistics supernetwork model. The above research is based on the supernetwork theory, combine the logistics network and other networks, to solve the optimization problem of logistics and manufacturing, logistics and road network stability and so on. However, the relationship between the internal factors of logistics network is not considered. This article will build a supernetwork model, which includes logistics supply network and demand network, seek the best matching degree between the two networks, and achieve the effective management of logistics network.

Logistics network can be viewed as a network consisting of demand network and supply network (Zhang & Wang, 2010). The load-point of Logistics demand network is composed of demand market and consumers, retailers, manufacturing enterprises and suppliers, the connection between each logistics link formed a line of logistics demand, Link logistics demand from starting and ending point of the line formed a chain of logistics demand, a number of logistics demand chains interweave together constitute the logistics demand network. Logistics supply network is the network composed of nodes and lines of fixed equipment, logistics mobile equipment, coupled with the logistics operation organization. It is the matching relationship between nodes and lines of Logistics demand network and Logistics supply network, and the connection will constitute a logistics supernetwork, therefore, the logistics supernetwork goal is maximum matching of supply and demand. Peng et al. (2013, 2014) has carried on the preliminary analysis and the discussion to the logistics supernetwork, which studied the question of single product distribution and the agricultural product random demand logistics supernetwork.

With the gradually development of society and the demand of the logistics industry, the diversification of commodities, the large scale of circulation is more and more obvious, logistics demand network and supply network will present a multiproduct, multi manufacturer, multilevel distribution node, multi demand user characteristics. Therefore, this paper constructs a multi commodity logistics demand supernetwork, which is built with the goal of maximizing the matching of supply and demand, and the model is converted into a variational inequality problem, using the modified projection algorithm, make lean coal and coking coal as an example, calculation is performed to obtain the matching degree of the coal logistics network, Put forward scheme to optimize the decision-making, compare and analyze the results before and after optimization.
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